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(54) Abstract Title
Compression coding of video data

(57) A DVD or other master compression operation is divided into a first step which produce a high bit rate primary coded bitstream. The maximum bit count for the DVD is then achieved in a second step of single or repeated transcoding of said primary bit-stream with no reference being made to the original video signal.

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COMPRESSION ENCODING OF VIDEO

This invention relates to MPEG and other compression encoding of video and is particularly concerned with non-real-time encoding applications such as DVD authoring.

A particular feature of DVD authoring is that whilst the maximum bit allocation is of course fixed by the storage capacity of the disc and the amount of ancillary material that the disc is also required to carry, the bit rate can, over the run length of the DVD, vary considerably with time. Advantage is taken of this feature to ensure that particularly critical material is encoded at high quality, at the expense of lowering the bit rate in less critical areas.

Current DVD authoring techniques generally involve a combined solution of a video tape recorder (VTR), a hardware MPEG2 encoder and an appropriate computer running control and authoring software and accessing bit-stream file storage. A typical process entails many sessions of playing the material from the VTR and encoding by the encoder, controlled precisely by the computer, with the resultant MPEG stream being captured by the computer. The approach is iterative, with each subsequent process of encoding the video being guided by the results of the previous attempts. The aim is achieve the desired quality throughout the material with the overall constraint of fitting the encoded MPEG within the target file size. Judging the desired quality in individual scenes or other sections of the video material is a subjective issue, often controlled – where the material is cinematographic film originating – by the film director, or by a quality control agent acting on his behalf.

There are a number of disadvantages associated with current techniques. For example, the current method requires full availability and close interaction of the VTR and the encoder throughout the authoring process. Also, the current method has limitations on the level of control that can be applied to the encoding process, such as the precise application of encoding effort to small portions of the material.

It is an object of the present invention to provide an improved compression coding process for use in DVD authoring or other applications where there exists a predetermined limit on the aggregate bit total.

Accordingly, the present invention consists in one aspect in a process for compression coding video material to produce a coded bitstream with a predetermined limit on the aggregate bit total, comprising a first step of compression encoding to produce a primary coded bitstream having an aggregate bit total substantially in excess of said limit and a second step of single or repeated transcoding of said primary bit-stream to produce a secondary bitstream having a variable bit rate and an aggregate bit total within said predetermined limit.

In a preferred form of the invention, a single reference encoding pass is performed at a generally fixed bit-rate.

In an alternative, a single reference encoding pass is performed at a generally fixed quality level.

This bit-rate is high enough to ensure that even the most demanding sections of the material (in terms of the difficulty of compression coding) are coded to give a quality level sufficient to give visibly perfect pictures. All subsequent alterations of the instantaneous bit-rate are performed by transcoding the original pass data, leaving coding modes unchanged. This transcoding is performed in software. In addition to coding modes, all other coding decisions that remain appropriate in the transcoding process, are re-used from the primary encoding.

This preferred form of the invention offers a number of specific advantages.

For example, the VTR and hardware MPEG encoder are only required for a single encoding session equal in time to the runtime of the material being encoded. Also, the task of controlling the VTR and hardware MPEG encoder is minimised.

There is greater flexibility in the control of the coding quality, as it is totally under the control of the transcoding software on the computer.

This invention will now be described by way of examples.

In the first step of a process according to one example of this invention, the source material in tape format is inserted into a VTR, and the start and end time-codes are set on a controlling computer. The computer instructs a hardware MPEG-2 encoder to process the material from the start time-code until the end time-code with a high quality level, sufficient for pictures that are visibly perfect. By "visibly perfect" is meant in practical terms a picture quality that is everywhere at least equal to the highest picture quality that might foreseeably be demanded for any one picture or sequence in the transcoded, output bit-stream. The computer starts the VTR, and captures the primary encoded bitstream to disk. Once the whole material has been played the VTR is stopped, and the VTR and encoder can be released for other uses.

The computer is then used to run transcoding MPEG-2 software to re-quantise the bit-stream, to achieve the desired quality within the permissible file size. This can be a multi-pass and/or multi-part operation, with quality assessments at various points.

In more detail, the first transcoding pass generates the variable bit-rate elementary stream (.vbs file). A parameter file, looking very similar to the SSG (Software Simulation Group: a public domain software encoder) .par file, is conveniently used to specify:-

Average bitrate
Max. bitrate
Min. bitrate
Min. quantiser
I, P & B relative quantisers
etc.

The Average bitrate is taken from the bit budget spreadsheet, the maximum bitrate is usually set to 8.8 Mbit/s and the minimum to around 1.25

Mbit/s. Exceeding these limits usually crashes the DVD players. In a more complex system, the rate control algorithm could make use of additional information from the reference pass.

The .vbs files are then subjected to a quality control (QC) process to check the video encoding quality. There will typically be a QC agent employed by the organisation responsible for the quality of the original picture material, and not by the organisation conducting the DVD authoring. The QC agent will be expected to view critically the decoded and displayed bit-stream and may single step through individual frames to pick-up problems. The QC agent will provide a set of notes indicating the nature of the fault and the timecode at which it occurred.

The scenes identified by the QC check are reviewed and an attempt is made to re-code them. In one application, the user is invited to enter an IN point, an OUT point and a bitrate scaling, between 0.5 and 2.0, relative to the old .vbs. (It might be necessary to release bit-rate from one scene to be able to allocate more to another). The system then re-codes the segment and invites the user to accept or reject the results. If accepted, a further file, rather like an EDL is annotated to indicate that the new elementary stream file should replace the first transcoded bitstream between the given timecodes.

Once all of the necessary scenes have been re-coded, the individual files are combined to provide a single .vbs file for the whole segment, rather like conforming an edit.

There are some important additional benefits of the transcoding approach according to the present invention. Because transcoding requires so much less processing than full re-encoding, it may be possible to do it faster than real time. So if the QC check identified a large number of changes, it may be more convenient to transcode the whole bitstream again rather than just the portions marked for change. In any case, because the system requires fewer hardware resources than the prior art, it would be possible to make more attempts to arrive at an ideal balance of subjective quality within the desired bit budget.

Another advantage of the present invention stems from the much greater control of the quantiser in software transcoding as compared with a real hardware encoder. It would be possible, for example, to identify discrete areas of the picture that are of particular interest to the viewer or producer (such as the actor's face or a product positioned for marketing purposes) and to ensure that quantisation is particularly fine for the identified picture area. Other parameters can also be tuned to ensure that particularly critical areas of a picture can be encoded at the highest quality.

By ensuring that the partial or complete re-encode process that is inherent in the transcoding process, uses so far as is practicable the same coding decisions as the primary encoding operation, cascade losses are avoided or minimised. For a discussion of this concept, reference is directed to WO95/35628, WO98/03017, and PCT/GB99/00228, which are hereby incorporated by reference. In these same references, is a discussion of a partial decode process that might be relevant in the present context

In another embodiment, which shares some but not all of the advantages mentioned above, the reference encoding pass is replaced by an analysis of the video material to determine what coding decisions a hardware compression encoder would have taken in encoding the material. The first transcoding step is then replaced by a re-encoding process guided by those coding decisions. For a description of this type of pre-processing, reference is directed in particular to PCT/GB99/00228.

There would not be in this case be the same the saving in VTR use, but there would still be the possibility to save encoder resources and (using an HDTV VTR for example) the potential for faster-than-real-time operation.

CLAIMS

1. A process for compression coding video material to produce a coded bitstream with a predetermined limit on the aggregate bit total, comprising a first step of compression encoding to produce a primary coded bitstream having an aggregate bit total substantially in excess of said limit and a second step of single or repeated transcoding of said primary bit-stream to produce a secondary bitstream having a variable bit rate and an aggregate bit total within said predetermined limit.

2. A process according to Claim 1, wherein said first step is conducted on a dedicated hardware compression encoder and second step is conducted using compression transcoding software running on general purpose computing apparatus.

3. A process according to Claim 1 or Claim 2, wherein the first step of compression encoding is performed at a generally fixed bit rate.

4. A process according to Claim 1 or Claim 2, wherein the first step of compression encoding is performed at a generally fixed quality level.

5. A process according to any one of the preceding claims, wherein said first step is so adapted that the picture quality at every point in the primary coded bit-stream is at least as high as the highest demanded picture quality for any one picture in the secondary bit-stream.

6. A process according to any one of the preceding claims, wherein the compression encoding is based on MPEG .

7. A process according to any one of the preceding claims, for DVD authoring.

Application No: GB 9908772.8 **Examiner:** Joe McCann
Claims searched: All **Date of search:** 5 August 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H4F(FRT,FRC,FRP,FRG,FRD,FRM,FRX,FRW)

Int Cl (Ed.6): H04N(7/26)

Other: Online: WPI, JAPIO, EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0805592A2	(INTEL CORP) - see abstract	1,2,4,6,7
X	EP 0262731A	(PHILLIPS) - see abstract	1-4,6,7
X	WO 97/33436A1	(SIEMENS) - see abstract	1-4,6,7
X	WO 95/28684A1	(MOTOROLA INC) - see abstract	1-4,6,7

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.